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DEMONSTRATION OF CRATER-BASED NAVIGATION FOR AUTONOMOUS MOON ORBITING AND LANDING APPLICATIONS

Abstract

Many private companies are currently working on the development of Moon landing systems with the objective of providing commercial landing services to space agencies, research institutes and private organisations. In order to be able to land at all lunar sites of interest for the customers, it is required to overcome the challenges related to providing global access, including reaching the desired area with great accuracy and landing on various types of terrains. Therefore, future landing systems need to be equipped with high-accuracy navigation systems to accurately reach the target.

One of the considered approaches for absolute navigation is optical crater-based navigation. This technique processes camera images during the descent, extracts craters from the images, and matches the detected craters with a pre-stored reference crater map. It outputs an estimate of the Lander location with respect to the reference map. It allows estimating the Lander absolute position in low Lunar orbit and during the descent orbit to refine the Lander position estimate to increase the accuracy at touchdown. It is claimed that it provides a position estimation accuracy compatible with missions requiring a touchdown accuracy of 100 m or better.

Such technology has been successfully demonstrated in software simulation environments and in scaled dynamic laboratory environments. The next logical step is to perform demonstration using actual flight data. A study is on-going to perform the first ever crater-based Absolute Navigation operation demonstration from low-lunar orbit. During the first phase of this study, orbital imagery from the ispace M1 mission is used to demonstrate crater-based navigation execution offline, on ground. This first phase also addresses the development of a reference crater database from available Moon surface information, which is another important objective of the demonstration. During the second phase, the software will be integrated and operated in real-time on-board the Firefly Blue Ghost Lander during its first Moon mission.

The paper will present the latest status of the crater-based navigation demonstration activities, including crater-based navigation results using the ispace M1 mission imagery. This will enable the validation

of the database generation process and a quantitative assessment of the system accuracy by comparing the system outputs with ground-based orbit determination.